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Theses of the Doctoral Dissertation

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Supporting sports performance with psychophysiological methods

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List of publications that the dissertation is based upon:

Ábel, K. E., Komáromi, L., Hungarian University of Sports Science, Budapest, Hungary, Szabo, A., & Institute of Health Promotion and Sport Sciences, ELTE Eötvös Loránd University, Budapest, Hungary. (2024). Reasons For Exercise and Training-Induced Affective Changes in Co-active and Interactive Sports. *Cognition, Brain, Behavior. An Interdisciplinary Journal*, *28*(1), 39–51. https://doi.org/10.24193/cbb.2024.28.03

Ábel, K. E., Mihalik, Z., Soós, I., Boros, S., & Szabo, A. (2023). Avoidance of fitness or sports facilities during a lockdown: Gender and training environment could be protective factors. *Heliyon*, *9*(3), e13808. https://doi.org/10.1016/j.heliyon.2023.e13808

Ábel, K., Rausz-Szabó, A., & Szabo, A. (2020). Heart Rate Reactivity to Mental Stress in Athlete and Non-Athlete Children. *Baltic Journal of Sport and Health Sciences*, *3*, 4–12. https://doi.org/10.33607/bjshs.v3i118.969

Ábel, K., Somlai, F., & Szabo, A. (2023). Acute mental benefits of aquatic exercises in middle-aged women. *Mentálhigiéné És Pszichoszomatika*, *24*(1), 75–81. https://doi.org/10.1556/0406.2023.00007

Ábel, K., Szabo, A., & Rausz-Szabó, A. (2022). Psychological effects of 50-meter swimming: Does tempo manipulation matter? *German Journal of Exercise and Sport Research*, *52*. https://doi.org/10.1007/s12662-022-00829-8

Introduction

Emotions, physical activity and motivation

Emotions always play an important role in sport. The positive emotions experienced during exercise help to maintain motivation for physical activity (Ekkekakis & Brand, 2019). Psychological experience is a key factor for endurance during the initial stages of exercise, as conceptualised by hedonic theory (Higgins, 1997). Increasing pace affects arousal levels (Husain et al., 2002), which represent the activation dimension in the core affect circumplex model. Previously, an increase in core affect has been demonstrated during as short

as 3 min of light physical activity (Szabo, 2013). The two dimensions of core affect are described by Russell (1980) as a construct of arousal level and affective valence (such as pleasure or displeasure).

The exercise motivation can be classified into two main categories: 1) health maintenance, skill development, and 2) mastery, self-improvement (Szabo et al., 2019). There is also a third category that emphasizes the enjoyment of exercise and the social aspects (Rajkumar, 2020). The motivation for lifetime exercise was presented by Pahmeier (2008) in his heuristic model. Self-Determination Theory (Ryan & Deci, 2000) provides important support to clarify the motivation to participate in sport. A key factor of the theory is the need for autonomy, which is related to intrinsic, extrinsic and amotivation.

What affective changes does aquafitness induce?[1] – 1. study

Background: Aquatic exercises are popular leisure activities worldwide, primarily among women. These activities are especially beneficial for aging people and individuals having difficulties performing land-based exercises. Their physical health benefits have already been documented in the academic literature, but research on their mental health effects is still non-existent. However, leisure exercises promoting mental health are advantageous in a fast-paced and often stressful world. Therefore, in this in-situ (natural life setting) field study, we examined the acute mental benefits of aquatic exercises in 30 voluntary consenting women having a mean age of 57.57 (SD = 12.67) years.

Methods: Using a within-participants research design, the subjectively perceived feeling states and felt arousal, along with positive and negative affect, were recorded before and after exercise. Moreover, the personal expectancies regarding the expected feelings after exercise were assessed before the workout to determine the influence of anticipation effects.

[1] The original article on which the chapter is based: Ábel, K., Somlai, F., & Szabo, A. (2023a). Acute mental benefits of aquatic exercises in middle-aged women. *Mentálhigiéné És Pszichoszomatika*, *24*(1), 75–81. https://doi.org/10.1556/0406.2023.00007

Results: The findings revealed that core affect and positive affect improved substantially from before to after exercise ($p < .001$), as confirmed by the large effect sizes (Cohen's $d > 0.80$). Negative affect decreased nonsignificantly ($p = .062$), but it was already low before exercise. Although expectancy scores were high before the exercise class, they did not correlate ($p > .05$) with the dependent measures' magnitude of changes (pre-class – post-class scores).

Descriptive statistics and ranges of ratings in five dependent measures before and after aquatic exercise class (*n = 30)*

Dependent measures	Before exercise M (SD)	After exercise M (SD)	Perent (%) change	Range of ratings (min. - max.)
Expectations	4.57 (0.73)	-	-	1 – 5
Feeling state	3.07 (1.46)	4.87 (0.43)	58%	-5 – +5
Felt arousal	3.70 (0.92)	5.07 (0.79)	37%	1 – 6
Positive affect	3.82 (0.65)	4.37 (0.61)	14%	1 – 5
Negative affect	1.14 (0.22)	1.05 (0.14)	8%	1 – 5

Conclusions: These findings suggest that women who participate in an aquatic exercise class report experiencing significant positive changes in their feelings, demonstrating this popular exercise's acute mental health benefits. Although further controlled research is needed in this area, the current results have promising implications for middle-aged women's mental health preservation and promotion.

What are the psychological effects of swimming 50 metres?[2] – 2. study

Background: Swimming is one of the world's most popular recreational exercises and sports. Scholastic writings consistently demonstrate their physical and mental benefits. In contrast to earlier works, the current field experiment examined whether an ultrashort 50 m bout of swimming could yield positive changes in affect. It also tested whether swimming aided by

[2] The original article on which the chapter is based: Ábel, K., Szabó Rausz, A., & Szabo, A. (2022). Psychological effects of 50-meter swimming: Does tempo manipulation matter? *German Journal of Exercise and Sport Research*, *52*. https://doi.org/10.1007/s12662-022-00829-8

steady and augmenting tempo (drumbeats) could generate additional psychological benefits, abbreviate swim time, and increase heart rate and perceived effort.

Methods: Forty-eight adults completed freestyle or breaststroke 50 m laps in three counterbalanced conditions.

Results: The tempo manipulation did not influence any of the measures. However, simmers' core affect increased as manifested in higher self-reported feeling states and arousal, regardless of the experimental condition. Similarly, participants' positive affect was also increased after 50 m laps, and it was higher in breaststroke than freestyle swimmers throughout the study. No changes emerged in negative affect due to floor effects.

Descriptive statistics and the results of Greenhouse–Geisser-corrected univariate F tests of the six psychological measures before and after three swimming conditions (n = 48)

Measure	**Baseline**	**Swimming without drumbeats**	**Swimming with steady tempo beats**	**Swimming with augmenting tempo beats**	***F***	***p***	**Effect size (ηp^2)**
Feeling	3.42 (1.27)[a]	4.04 (1.20)[b]	4.02 (1.16)[b]	4.06 (1.14)[b]	5.79	= .002	.12
Arousal	4.08 (0.99)[a]	5.19 (0.84)[b]	5.19 (0.89)[b]	5.08 (0.85)[b]	25.73	< .001	.37
Positive affect	3.57 (0.74)[a]	4.16 (0.65)[b]	4.24 (0.73)[b]	4.24 (0.72)[b]	27.34	< .001	.38
Negative affec	1.17 (0.41)	1.07 (0.32)	1.13 (0.37)	1.13 (0.46)	1.28	NS.	-
Physical exhaustion	1.84 (0.90)	1.99 (0.93)	1.87 (0.91)	1.77 (0.84)	0.89	NS.	-
Tranquillity	3.63 (0.69)	3.56 (0.94)	3.65 (0.99)	3.61 (1.03)	0.26	NS.	-

Notes: 1) NS: Not Significant, M: mean, SD: standard deviation 2) [a,b]Bonferroni corrected pairwise comparisons indicated that compared to preswimming baseline ([a]), in all three swimming conditions ([b]) feeling state, felt arousal, and positive affect were statistically significantly higher ($p < 0.05$)

Conclusions: These results show that core and positive affect improve after *less than one minute* of swimming, which might be the shortest ever exercise interval associated with positive psychological changes in recreational exercise. Several possible explanations could account for these findings. Therefore, further research is needed to identify the specific mechanism(s) responsible for the current results.

Do children in sport recover faster after stressful situations compared to non-athletes?[3] **– 3. study**

Background: Research suggests that exercise training and/or physical fitness may be associated with lower heart rate reactivity and faster recovery from psychosocial stress. This relationship was rarely studied in children despite the potential protective role of physical activity in stress that may start in early life stages.

Methods: In this laboratory investigation we examined 18 athlete and non-athlete children before, during and following exposure to mental stress which consisted of the Stroop Color Word Task and a mental arithmetic task, both distracted by classical music, in a counterbalanced research design.

The results based on absolute heart rate measures suggested that athletes exhibited lower heart rates in the stress-anticipation period as well as during the stress period than non-athletes. However, based on relative measures these differences vanished. The two groups of children did not differ in perceived arousal, perceived stressfulness of the mental tasks, and the self-reported feeling states before and after stress. Further, they did not differ in their performance on the two stress-eliciting active-coping tasks as indicated by the number of correct answers.

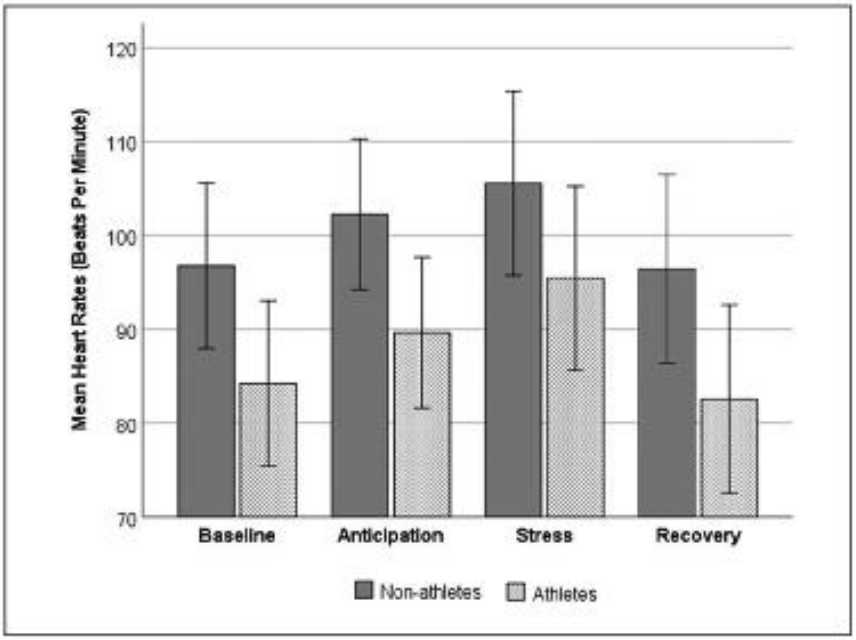
[3] The original article on which the chapter is based: Ábel, K., Rausz Szabó, A., & Szabo, A. (2020). Heart Rate Reactivity to Mental Stress in Athlete and Non-Athlete Children. *Baltic Journal of Sport and Health Sciences*, *3*, 4–12. https://doi.org/10.33607/bjshs.v3i118.969

Summary of Mann–Whitney U tests comparing athlete and non-athlete children

Measures	Groups (n = 18, 9 / group)	Mean rank	*Z*	*p*	Effect size (r)
Weekly hours of exercise	Athlete	13.78	-3.44	<.001	.811
	Non-athlete	5.22			
Baseline (1) HR (3 min)	Athlete	7.17	-1.86	.063* NS	.431
	Non-athlete	11.83			
Anticipation (2) HR	Athlete	6.39	-2.48	.013	.585
	Non-athlete	12.61			
Stress (3) HR	Athlete	6.67	-2.25	.024	.530
	Non-athlete	12.33			
Recovery (4) HR	Athlete	7.11	-1.90	.057* NS	.448
	Non-athlete	11.89			
Arousal baseline	Athlete	9.33	-.15	.884 NS	.035
	Non-athlete	9.67			
Arousal anticipation, before stress	Athlete	8.89	-.51	.611 NS	.120
	Non-athlete	10.11			
Arousal after stress	Athlete	10.22	-.60	.552 NS	.141
	Non-athlete	8.78			
Arousal during recovery	Athlete	9.22	-.23	.0820 NS	.054
	Non-athlete	9.78			
Feeling state baseline	Athlete	11.67	-1.81	.070 NS	.427
	Non-athlete	7.33			
Feeling state anticipation, before stress	Athlete	10.78	-1.05	.292 NS	.247
	Non-athlete	8.22			
Feeling after stress	Athlete	10.61	-.90	.366 NS	.212
	Non-athlete	8.39			
Feeling state during recovery	Athlete	9.72	-.19	.852 NS	.045
	Non-athlete	9.28			
Stressfulness of the tasks	Athlete	11.06	-1.28	.201 NS	.302
	Non-athlete	7.94			
Performance on SCWT	Athlete	10.17	-.53	.594 NS	.125
	Non-athlete	8.83			
Performance on MA	Athlete	9.89	-.31	.755 NS	.073
	Non-athlete	9.11			

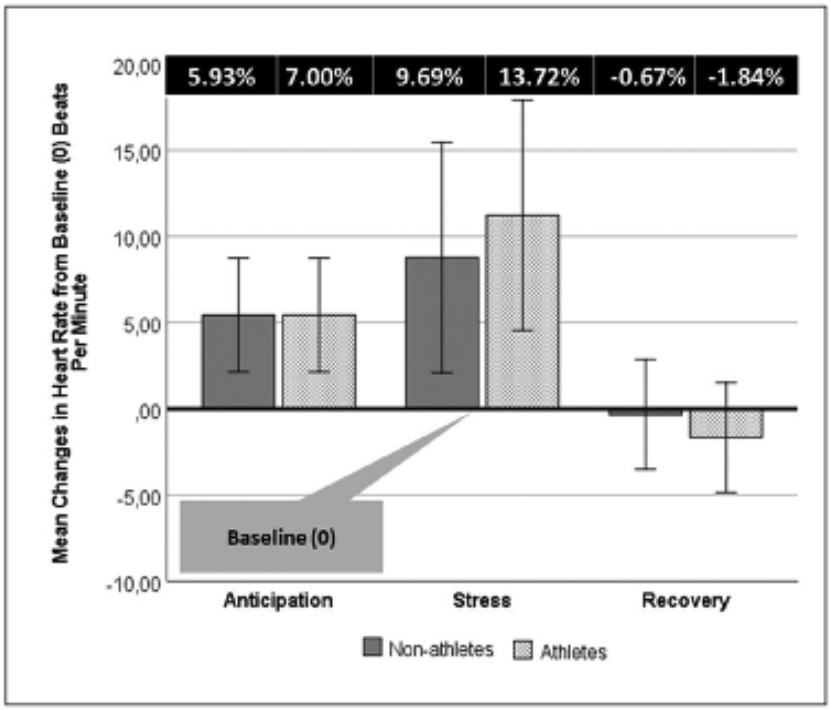
*Note. * May be considered a trend; HR = Heart Rate; MA = Mental Arithmetic; NS = nonsignificant; SCWT = Stroop Color Word Task*

Heart rates at baseline and in three phases of stress exposure



Note. Error bars represent the 95% confidence intervals

Relative (to baseline) changes in heart rate in three phases of stress exposure



Notes. Error bars represent the 95% confidence intervals. No statistically significant group differences were observed as based on Mann-Whitney U tests.

Conclusion: These results appear to suggest that athletic status in children is unrelated to heart rate reactivity and other subjective psychological experiences before, during and after acute psychosocial stress.

Is there a difference between the affective effects of interactive and co-active training?[4] – 4. study

Background: Generally, in interactive sports, one focuses on performance-related field events, cooperation, and coordination rather than subjective feelings. Therefore, we hypothesized that subjectively perceived positive affect would rise immediately after co-active but not interactive exercise training.

Methods: We used the Exercise-Induced Feeling Inventory (EFI) to test positive engagement, revitalization, tranquility, and physical exhaustion pre- and post-training in 107, primarily male, university students practicing either co-active (aerobic exercise, martial arts, swimming; N =54) or interactive (basketball, soccer, football; N=53) sports. We also assessed their enthusiasm before training and perceived exertion after training. Training-induced affective changes in the dependent measures were expressed as percentage change scores and subjected to multivariate covariance analyses.

The results did not support our hypothesis that co-active exercisers experience more positive affective states due to training than interactive exercisers. However, co-active exercisers reported more enthusiasm before training and greater physical exhaustion after the training than interactive exercisers. There was also a statistically non-significant trend in the ratios of the reasons for exercise participation, with more than two-thirds of co-active exercisers training for health reasons compared to less than half of interactive exercisers who participated more for mastery and enjoyment reasons.

[4] The original article on which the chapter is based: Ábel, K. E., Komáromi, L., & Szabo, A. (2024). Reasons For Exercise and Training-Induced Affective Changes in Co-active and Interactive Sports. *Cognition, Brain, Behavior. An interdisciplinary journal*, *28*(1), 39–51. https://doi.org/10.24193/cbb.2024.28.03

Between groups differences in four affective states at baseline (before exercise training)

Independent Samples Test										
	Levene's Test for Equality of Variances		t-test for Equality of Means							
	F	*p*	t	df	Significance		MD	SED	95% Confidence Interval of the Difference	
					One-Sided p	Two-Sided p			Lower	Upper
Exhaustion	.733	.394	1.274	116	.103	.205	.185	.145	-.103	.473
Revitalization	1.783	.184	-.328	116	.372	.744	-.046	.141	-.325	.233
Tranquility	.860	.356	-.255	116	.399	.799	-.040	.160	-.349	.269
Positive engagement	.527	.469	-2.085	116	.020	.039	-.254	.122	-.495	-.013

Note: MD = Mean Difference; SED = Standard Error of the Difference

Three categories of reasons are given for maintaining regular physical activity by co-active and interactive exercisers

Reasons	Number of exercisers	
	Coactive	Interactive
Health	38 (70.4%)	25 (48.1%)
Mastery	9 (16.7%)	13 (25.0%)
Enjoyment	7 (13.0%)	14 (26.9%)

Note: One individual did not respond to this question

Conclusion: These results suggest that affective states following a single exercise bout do not differ between co-active and interactive exercisers. However, enthusiasm differences between these forms of sports could be related to self-centered, attentional-focused training, health-related motivation, and more exhaustive training.

Are women or men more cautious about exercising during lockdown?[5] – 5. study

Background: The COVID-19 pandemic has swept the world, claiming nearly seven million lives by now. Despite a decline in the mortality rate, in November 2022, the virus-linked death cases still exceeded 500 every day. There is a belief that it is over now, but similar health-crisis situations may re-occur, and therefore it is essential to learn from such human disasters. It is an accepted fact that the pandemic has changed people's lives worldwide. One specifically and significantly affected life domain, especially during the lockdown, is the practice of sports and planned physical activities.

Methods: Hence, this study examined the exercise practices and attitudes towards attending fitness facilities in 3053 working adults during the pandemic, along with the differences associated with the preferred training environment, including fitness/sports facilities, home, outdoor, or their combinations.

The results revealed that women (representing 55.3% of the sample) are more precautious than men. Further, exercise behavior and COVID-19 attitudes broadly vary among people choosing different training venues. In addition, age, exercise frequency, place of exercise, fear of infection, flexibility in training form, and desire to exercise freely are predictors of non-attendance (avoidance) of fitness/sports facilities during the lockdown.

[5] The original article on which the chapter is based: Ábel, K. E., Mihalik, Z., Soós, I., Boros, S., & Szabo, A. (2023b). Avoidance of fitness or sports facilities during a lockdown: Gender and training environment could be protective factors. *Heliyon*, *9*(3), e13808. https://doi.org/10.1016/j.heliyon.2023.e13808

Results of the Chi-square tests examining gender differences

Questions	Percent 'yes' answers	χ^2 (df = 1)	*n*	*OR*	95% *Confidence interval*		*p*
					Lower	Higher	
Attended a fitness/sports facility during lockdown (yes, no)	Men 32.60% Women 26.22%	14.83	3041	1.36	1.16	1.59	<.001
Online training can replace fitness/sports facility training (yes, no)	Men 3.83% Women 8.03%	22.93	3040	.46	.33	0.63	<.001
Would switch training forms on a long-term basis (yes, no)	Men 2.87% Women 5.72%	14.34	3036	.49	.33	0.71	<.001
Fitness/sports facilities pose a greater risk of COVID-19 infection than supermarkets (yes, no)	Men 31.81% Women 31.34%	0.07	3030	1.02	0.88	1.19	=.783
	Percent total	**χ^2 (*df* = 4)**	***n***	**γ***	**95% Confidence interval of γ**		***p***
					Lower	**Higher**	
Exercise frequency	Men 44.68% Women 55.32	33.21	3042	−.16	−.22	−.10	<.001

*Table note: χ2 =Chi-square value; n =number of total observations; OR =Odds Ratio; p =level of statistical significance of the Chi-square test; γ = gamma; * due to 2 by 5 contincency table, not the OR but ordinal gamma (γ) and its 95% confidence interval were calculated.*

The significant predictors of not attending a fitness facility during the pandemic

Predictor	*B*	*S.E.*	Wald	*df*	*p*	*OR*	95%-os CI	
							lower	higher
Age			**28.265**	**3**	**<.001**			
Age range 25–39 years	.203	.217	.880	1	.348*	1.226	.801	1.875
Age range 40–54 years	.684	.230	8.840	1	.003	1.981	1.262	3.109
Age > 55 years	.976	.344	8.070	1	.004	2.654	1.353	5.205
Exercise frequency			**41.103**	**4**	**<.001**			
Once or twice a week	-.090	.358	.063	1	.801	.914	.453	1.842
Three or four times a week	-.559	.347	2.591	1	.107	.572	.289	1.129
Exercising 5–6 times a week	-1.029	.357	8.304	1	.004	.357	.177	.719
Exercising every day	-.976	.417	5.477	1	.019	.377	.166	.853
Place of Exercise			**16.110**	**6**	**.013**			
Home	-.369	.212	3.040	1	.081	.691	.457	1.047
Outdoor	.097	.517	.035	1	.851	1.102	.400	3.036
F/SF and outdoor	.702	.454	2.389	1	.122	2.018	.828	4.915
Home and Outdoor	-.201	.215	.876	1	.349	.818	.537	1.246
F/SF, Home, and Outdoor	1.041	.573	3.306	1	.069	2.833	.922	8.707
F/SF and Home	−.063	.242	.069	1	.793	.939	.584	1.509

Eager for fitness/sports facilities to reopen	.155	.075	4.239	1	.039	1.168	1.007	1.354
Fear of attending a fitness/sports facility	.135	.047	8.386	1	.004	1.144	1.045	1.254
Keen to switch training forms to avoid infection	.131	.043	9.394	1	.002	1.140	1.048	1.240

*Table note: * =The contrast variable is the first category. B =the regression coefficient; S.E. =Standard Error; Wald =chi-square value; df =degrees* of freedom, p =level of statistical significance; OR = Odds Ratio; C.I. =95% Confidence Interval.

Conclusion: These results expand earlier findings to exercise settings, suggesting that women are more precautious than men in the exercise context too. They are also the first to indicate that the preferred exercise environment entails attitudes that shape exercise patterns and beliefs associated with the pandemic differently. Therefore, men and regular fitness center attendees need more attention and special guidance in enforcing legislative prevention measures during a health crisis.

Other studies:

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